MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2 2017/2018

TRT 3241- REAL-TIME SYSTEMS

(All sections / Groups)

17 March 2018
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This examination paper consists of 4 pages (including the cover page) with 6 questions only.
2. All questions carry equal marks. The allocation of marks for each question is given in the paper.
3. Answer **ALL** questions.
4. Write your answers in the answer booklet provided.

Question 1 [10 marks]

a) Identify the key differences between hard real-time systems, soft real-time systems, and firm real-time systems. [3 marks]

b) Identify measure(s) that can be be used to inform the following attributes of real-time operating system (RTOS):
   i. Reliability
   ii. Predictability
   iii. Performance
   iv. Scalability
[2 marks]

c) List **TWO** problems of a centralized real-time control system. [2 marks]

d) Describe **THREE** characteristics of real-time embedded systems. [3 marks]

Question 2 [10 marks]

a) It is common to use serial communication methods due to distances between computers at higher operational levels in real-time systems. Write **FOUR** characteristics of serial communication methods. [4 marks]

b) Choose **TWO** techniques that can be used to drive voltage amplitude in the actuator Analog Back End (ABE) by a stream of digital encoded outputs. [2 marks]

c) The following statements represent functional requirements of an aircraft monitoring system:
   - The system shall perform various aircraft monitoring and recording functions.
   - The aircraft has one engine fitted with pressure and temperature sensors.
   - When three consecutive readings from each sensor were found to be out of range, a lamp corresponding to the sensor is changed from green to red.
   - A number of smoke detectors are installed in the aircraft. When smoke is first detected, an interrupt is generated by the smoke detectors.
   - The system shall switch a smoke warning lamp from green to red when a smoke detection interrupt occurs.

Using a block diagram, demonstrate the input and output devices of the system. [4 marks]

Continued...

Question 3 [10 marks]

a) Explain **ONE** argument that advocates for language-based concurrency. [1 mark]

b) Kernel is the smallest portion of an operating system (OS) that provides task scheduling, dispatching, and inter-task communication.

Compare the **FIVE** design of kernels. [5 marks]

c) Scheduling involves the allocation of resource and time to tasks in such a way that certain performance requirements are met. Several scheduling classes emerge, depending on:

i. Whether a system performs schedulability analysis.
ii. If it does, whether it is done statically or dynamically.
iii. Whether the result of the analysis itself produces a schedule or plan according to which tasks are dispatched at run-time.

Based on this, describe **FOUR** classes of scheduling algorithms. [4 marks]

Question 4 [10 marks]

a) Design the timing constraints for the following air-defense system. Classify each constraint into either performance or behavioral constraint.

Every incoming missile must be detected within 0.2 seconds of its entering the radar coverage area. The intercept missile should be engaged within 5 seconds of detection of the target missile. The intercept missile should be fired after 0.1 seconds of its engagement but no later than 1 second.

[6 marks]

b) Performance and behavioural constraints can be further classified into **THREE** types as follows:

i. Deadline constraint.
ii. Delay constraint.
iii. Duration constraint.

Explain each type of the constraints. [3 marks]

Continued...

c) A firing of a transition represents an occurrence of an event or an action has been taken. Explain **ONE** condition that allows the transition to be fireable.

[1 mark]

Question 5 [10 marks]

a) Consider the following hospital's patient monitoring system:

> *Each patient is connected to machines monitoring blood pressure, heart rate, and EKG. These machines issue a Boolean signal indicating a FAIL or NO FAIL condition. The results of each of these machines are Or-ed together to form a signal called ALARM. The ALARM signals for each of the rooms (one patient per room) are then Or-ed together and sent to the nurse's station. If any machine on any patient indicated a failure, the emergency alarm is sounded and the nurse is directed to the appropriate patient and machine.*

Compose a Petri Net representation for such a system.

[5 marks]

b) Based on the following **FIVE** criteria, compare the key differences between N-Version programming and Recovery Block approaches:

i. Redundancy.
ii. Design overheads.
iii. Run-time overheads.
iv. Error detection.
v. Atomicity.

[5 marks]

Question 6 [10 marks]

a) Describe **THREE** attributes of system dependability.

[3 marks]

b) Fault tolerance is the ability of the system to continue to function in the presence of hardware or software failures. Explain **THREE** levels of fault tolerance.

[3 marks]

c) Describe the **FOUR** phases in software dynamic redundancy.

[4 marks]

End of Paper.